**Part1. Network Hardware**

In this part, the major network hardware including switch, router, modem, host, network interface card is discussed.

Switch

To understand switch, it is helpful to know about history regarding the fact that why it was invented. Before the era of switch, there was a machine called Hub. It is connected to different network edges (computers) to receive and send data. However, the problem was that Hub sends data to every edge that increases traffic and causing security issues. Therefore, the machine called switch was introduced replacing Hub. Switch, on the other hand, receives data and send it to exact destination using MAC address. This result in reduction of traffic compared to Hub. Switch is used for data exchange within a local area network. This means that they are not used outside their own network.

Router

In order to use network outside the local network (such as LAN), router comes in a place to fill the gap. Routers are placed on internet network and forwards data from one network area to another using Internet Protocol (IP) addresses. When a data packet leaves a local area network to internet network, it enters router. The Router then reads the IP address of the data packet and sends it to the next router or destination edge. Compare to switch, routers are used for network connections, while switches are used for network creation.

Reference: <https://www.youtube.com/watch?v=1z0ULvg_pW8>

Modem

Modem is often compared to router since the role of them resembles each other. However, they have distinctive role. Modem is also called demodulator and modulator. Since internet and computer (end point users) have their own different signal types such as analogue and digital signals. Computer can only interpret digital signals, while the internet is only able to read analogue signals. Because of this, Modem is in placed to demodulate when computer receives signals from the internet and to modulate when computer sends signals to the internet. Router’s role is to distribute the pipe to different devices so that more than one device can connect to internet. Overall, modem act as a translator that translates signals bilaterally.

Reference (<https://www.youtube.com/watch?v=Mad4kQ5835Y>) , (lecture 1 note)

Host

According to Kurose(2020), host is all computing devices that are connected to communication link and packet switch (page3,4). This means that host can be a client and a server. Kurose describes host as an end system. This gives an idea about image of host such as personal computers, mobile Those are very common devices of daily life. Server computer, which hardly imagine for those who are not in technology field, can also belong to end system which makes it a host as well.

Reference (Kurose)

Network Interface Card

Network interface card (NIC), so-called network adapter, is core of network adapter that includes link-layer controller (Kurose, 2222, p.437). This means that it allows computer device to connect to computer network. NIC’s role resembles middleman between computer and network. For instance, when a client requests a web page, the request message is passed through NIC and is converted to electronic signal. Overall, NIC is just as modem that converts request to electronic signals.

Reference (<https://searchnetworking.techtarget.com/definition/network-interface-card>) (Kurose)

**Part 2 Internet Protocol Stack**

Kurose explains about internet with nuts-and-bolts description. According to him, internet is a computer network binding trillions of devices which have computing functionalities (2017, p.30). In the network world, it can be divided by 5 different layers. It is also further divided into 7 layers namely ISO OSI reference model (see figure 2.1).

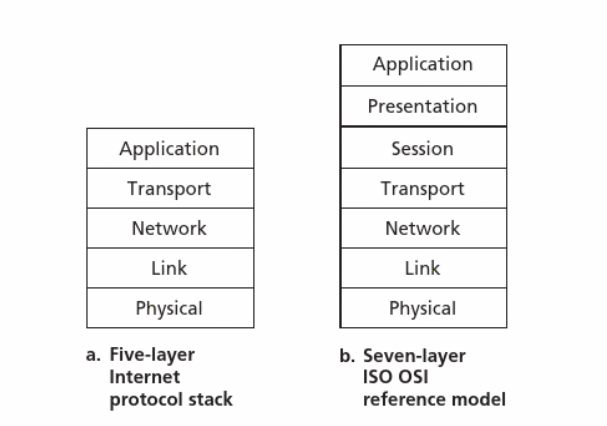


Figure 2.2

Kurose illustrates the internet layer architecture as a ticket to plane and deplane to arrival. Moreover, he explains about functionality of each layer comparing each service that a person will have. For example, a person should proceed ticketing and registering baggage to the airplane. The service that the person would have is ticketing service and bassage registering service (2017, p.76). Each service represents functionality of layer. This means that layers have their own functions within the protocols. In similar manner of airline architecture, each protocol of network layer architecture belongs to one of the layers (Kurose, 2017, p.77). In other word, one layer could be dependent to another layer. As aforementioned above with figure 2.2, the network layer can be described as 5 layers. In part 2, each layer is briefly explored. Then, Transport and Network layers are discussed more in depth since they are commonly associated famously knowingly as TCP/IP.

2.1.1. Application layer.

The application layer, as its name tells, it closely associates with applications of daily life such as web applications and email. Application layer includes a lot of protocols (Kurose, 2017, p.78). For example, http is one of representable protocol used for transferring web documents. SMTP is another commonly used protocol utilized in transferring email messages. The other protocol is FTP which transfers files to the end hosts. The protocols mentioned above might be familiar to even those who are not in technology field. However, domain name is almost every single person heard of. Domain name can be created with help of DNS (Domain Name System) (Kurose, 2017, p.78). DNS becomes possible in association with application layer protocols.

2.1.2 Transport Layer

The main role of transport layer is shipping data to applications endpoints (Kurose, 2017, p.79). In this layer, two protocols are used which are: TCP also known as Transmission Control Protocol and UDP knowingly User Datagram Protocol. Kurose (2017, p.79) introduces two traits of TCP. One is that it offers a connection-oriented service to applications. This allows guaranteed delivery with flow control. The second is that TCP shatters long message into shorter segments that allows control of data flow as well. UDP on the other hand, is a connectionless protocol offering a connectionless services to applications (Kurose, 2017, p.79). Unlike the what Kurose mentioned about traits of TCP, the traits of UDP are likely opposite of UDP such as no reliability and no management of data flow.

2.1.3 Network Layer

The main role of network layer is transferring network packets, in other word, datagram (Kurose, 2017, p.79). the datagram is moved from one host to another. According to Kurose (2017, p.79), in network layer, there is one Internet Protocol (IP) and many routing protocols. Kurose also mentioned that entire number of devices which have network layer in them should run the IP protocol. In addition, IP has function to prescribe information in the datagram known as fields. These fields influence on endpoints and routers defining their actions according to those fields. Routing protocols decide where datagram is passed through from source to destination.

2.1.4 Link Layer

As aforementioned above, datagram is shipped through several routers from source to destination or vice versa. In order to ship a packet, network layer depends on link layer (Kurose, 2017, p.79). Link layer is not only a helper of network layer, but also deliverer of datagram to the next node as well. The services that link layer provides relying on different link layer protocols which are, for example, Ethernet, Wifi, and DOCSIS (Kurose, 2017, p.79). A datagram needs to travel across different links with different link layer protocols. Kurose (2017, p.79) gave an example that some datagram flows under control of Ethernet and under control of PPP on the next link.

2.1.5 Physical Layer

Similar to link layer above, physical layer has similar role which is transferring bits in the frame – packets of link layer – from one node to another. According to Kurose (Kurose, 2017, p.79), it is link dependent not only virtual link but also actual links such as coper wire and fiber optic links. Since there are many different protocols depending on actual links, a bit is transferred in a different manner depending on the type of links.

2.1.6 Two Commonly Associated layers

People, even without a network technology background, might have heard TCP and IP as they deal with personal computers in their daily lives. As its byname indicates, TCP in the transport layer and IP in the network layer are the most associated layers. Kurose (2017, p.216-p.218) compares transport layer and network layer with cousins sending letters each other from East coast to West coast and West coast to East coast. 4 cousins live in West Cost and the other 4 cousins live in East coast. They send letters each other weekly. From West coast, David is responsible for gathering all mails sent by cousins from East coast. Mary, on the other side, is responsible for gathering all mails from West coast. They both have one more responsibility which is distributing the letters to the rest of kids in their houses. In this simple example, Kurose pointed that what David and Mary are doing is what is happening in the transport layer. In addition, what the mail postage service (delivering mails, traveling from East coast to West coast) is doing is what is happening in the network layer, too. Letters in envelops (messages from application) written by cousins (processes) collected by David and Mary (transport layer protocol) are sent to houses (hosts) using postal service (network layer protocol). In a word, network layer covers wider transaction, whereas transport layer covers local transaction. Therefore, sending messages from one host to another with distance of thousands of kilometers is possible because the processes of applications use a service provided by transport and network layers to send messages.

2.2. Kuross Rose protocol stack versus Open Connection Interconnection (OSI) 7 layered model.

As mentioned in part 2.1.1 to 2.1.5, when it comes to a top-down approach, computer network can be illustrated by 5 layers from application layer to physical layer. On the contrary, OSI model has 2 more layers namely presentation layer and session layer. Kurose (2017, p.80) mentioned that functionality of 5 layers – application, transport, network, link and physical – is about the same. The presentation layer, located right under the application layer, has a role of interpretation. It helps applications to communicate by translating the meaning of data. There are three main functionalities that this layer can perform which are: data compression, encryption, and description. This makes applications throw burdens away when dealing with format of data and its representation or storage. Session layer sets the range of data exchange as well as performing synchronization.

Part 3. Organizations

3.1. Telecommunication Standardization Sector (ITU-T)

ITU-T is a organization that is comprised of experts building an international standards knowingly ITU-T Recommendations. According to ITU-T, their contribution begins from international standardization of telegraph exchange to modern information communication technology ecosystem (<https://www.itu.int/en/ITU-T/about/Pages/default.aspx>). Since its history begins from 1865, it can be said that ITU-T is an alive witness of great technology changes.

3.2. Internet Engineering Task Force(IETF)

Similarly with above, IETF is an organization which is formed by many experts and businesses such as network architect, vandors, operaterator and many more. Its administration works based on different areas. IETF is in charge of managing and developing of internet protocol suite particularly TCP and IP. For this role, experts in IETF works on designing a range of ip addresses.

Reference: <https://www.ripe.net/participate/internet-governance/internet-technical-community/ietf>

3.3. International Standard Organization (ISO)

ISO is an international leading standardizer in global network area. It has 164 different branches in different countries. ISO introduces their roles with 4 different categories which are: developing standards, research, capacity building (resourcing), education (<https://www.iso.org/what-we-do.html>).

In relation to developing standard, one of ISO’s role, they built OSI model when internet protocols were just about a beginning stage. Kurose mentioned that influence of ISO on network education was significant that educational facilities took 7 layered OSI model to teach students (Kuross, p.80, 2017).

3.4. The Institute of Electrical and Electronics Engineers (IEEE)

As mentioned in above organizations, IEEE is not different when it comes to their roles. They are also a standardizer that have built network standards. IEEE contributed to input and output interface called parallel port used by early computers. One of its famous contribution is WIFI standards for wireless networking. As same as ISO, it provides education and publications.

<https://techterms.com/definition/ieee>